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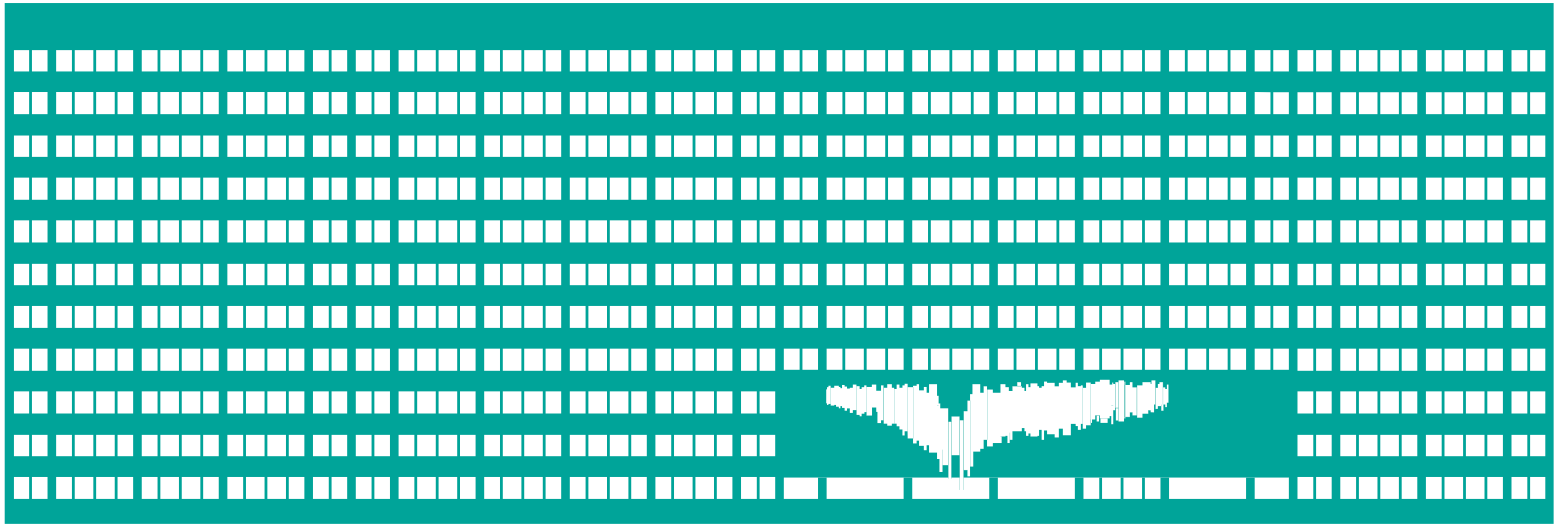

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Project TK03030037 New type of pumped-storage hydroelectric power plant is co-financed from the state budget by the Technology agency of the Czech Republic under the THÉTA 3 Programme.

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TK3030037

New type of Pumped-Storage Hydropower Plant

AVE

Ing. Roman Lukeš

Team Members:

Ing. M. Balco, Ph.D., Assoc. Ing. M. Bojko, Ph.D., Ing. et Ing. P. Čambala, Ing. O. Černý, J. Gadula, ***Prof. Ing. S. Honus, Ph.D.***, Ph.D, Assoc. Ing. V. Křivý, Ph.D., Ing. R. Lukeš, Ing. D. Mikolášek, Ing. P. Mynarčík, Ph.D., Ing. M. Pešek, Ph.D. MBA, Ing. Jiří Ptáček, Ph.D, Ing. Jan Toufar, Ph.D

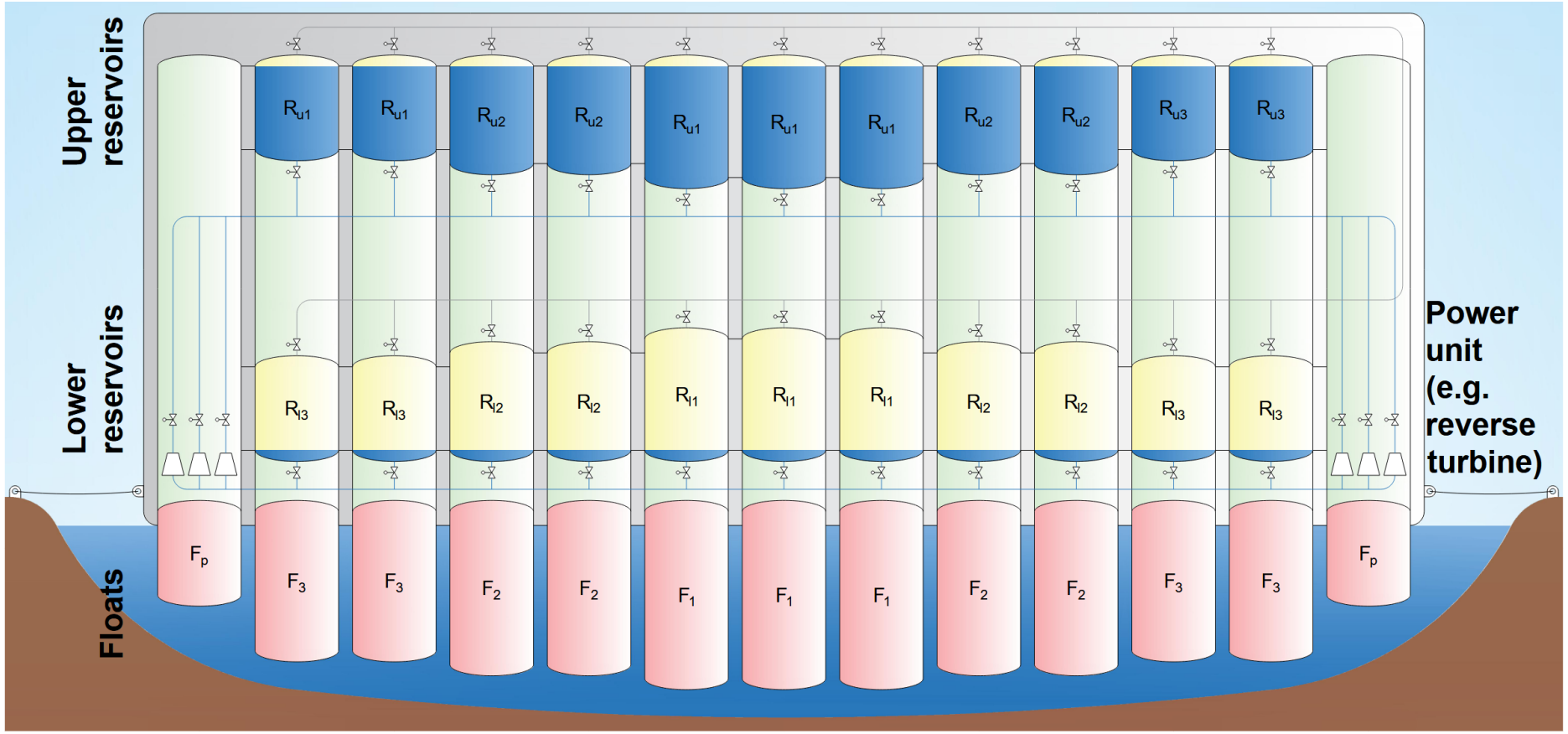
Presented Concepts

MPHES-2R – Modular Pumped-Storage Plant with Floating Reservoirs

MPHES-FR – Modular Pumped-Storage Plant with Fixed Reservoirs

MPHES-SFR – Modular Pumped-Storage Plant with Separated Fixed Reservoirs

MPHES-2R



power unit

automatically controlled control valve

pumped water in reservoirs

displaced air air/inert gas inreservoirs

air/inert gas in floats (pressurised)

air/inert gas in the intermediate tube

air/inert gas in the envelope of a storage power plant

R reservoir

F float

p power unit modules

1 first (main) depth level of modules

2 second depth level of modules

3 third depth level of modules

l lower

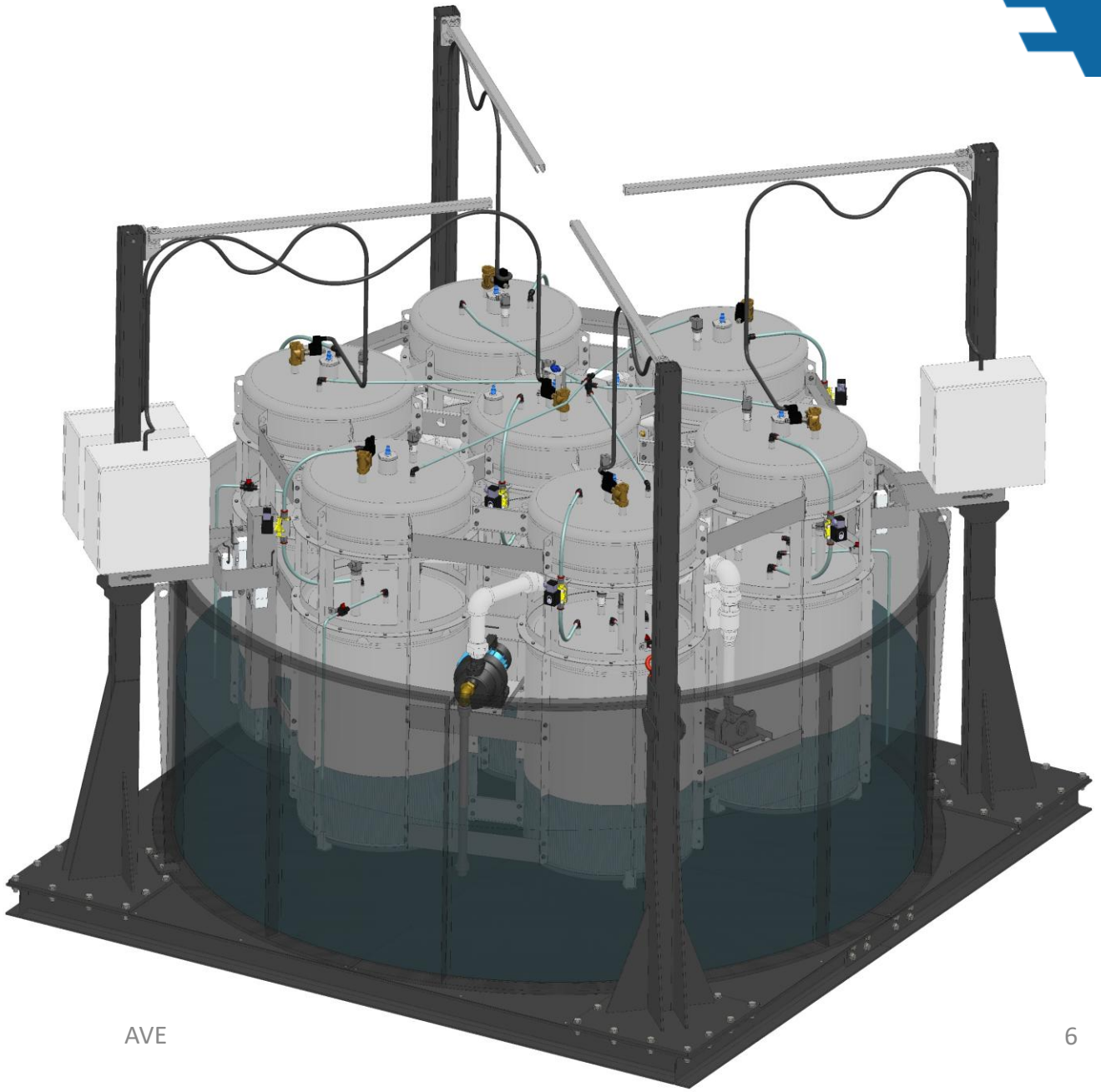
u upper

water pipes

air/gas pipes

Laboratory model MPHES-1R

- Small testing facility for evaluation of the stabilization system
- Built with intentionally unstable structure to simulate challenges
- Control software and regulation components reliably manage charging and discharging while maintaining safe and stable positioning
- Safety systems are designed for the most extreme operational and failure scenarios



Outdoor Model MPHES-2R

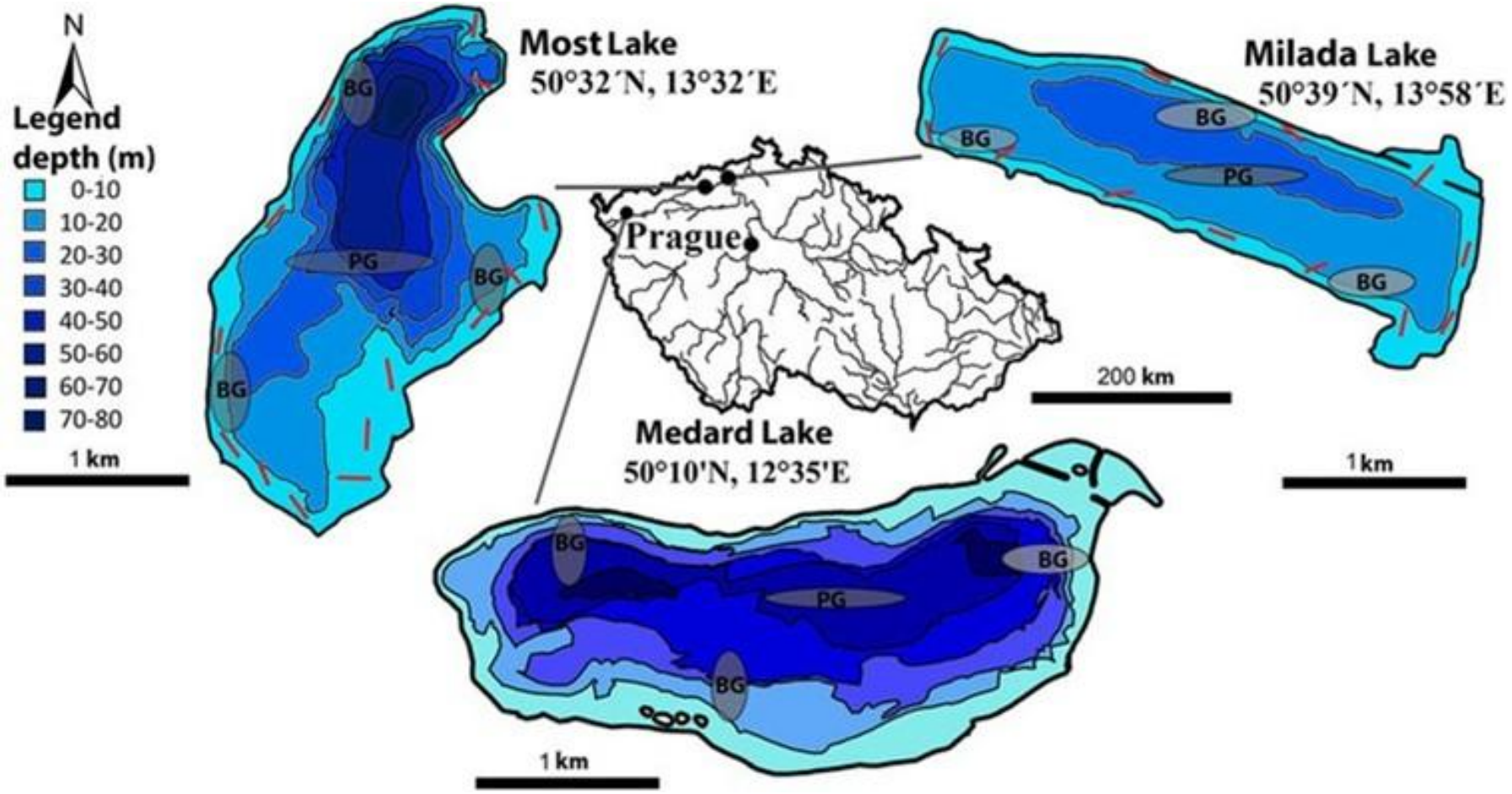
- Testing device for stabilization system under real conditions
- Irregular shape to simulate natural lakes
- Simulation of dynamic grid integration (with variable load and demand), connection to gasoline generator, photovoltaic panels, and wind turbine
- Long-term testing under variable operational conditions
- Dimensions 11 x 9 x 5,2 m

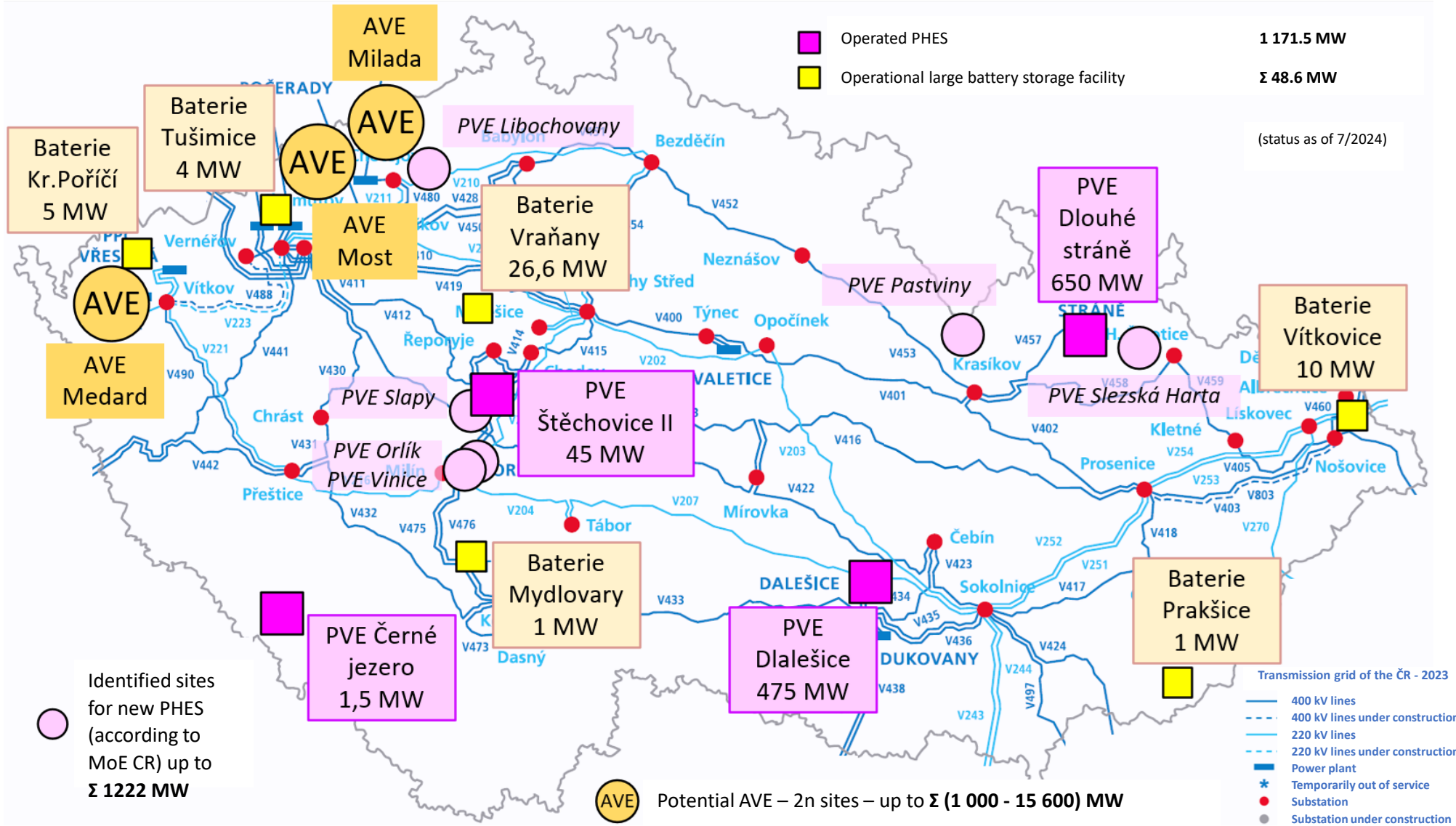
Outdoor Model MPHES-2R

Outdoor Model MPHES-2R

- Dimensions 11 x 9 x 5.2 m
- Power output: 0.9 kW (0.5 h…0.45kWh)

Depth Levels of Three Selected Artificial Lakes



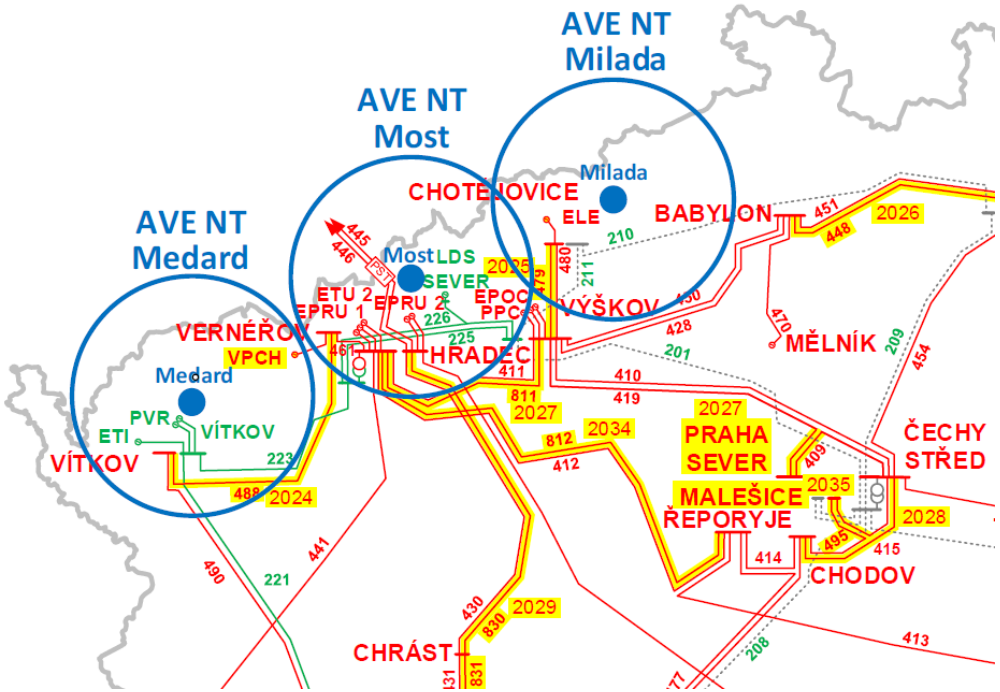

Operated PHES 1 171.5 MW
Operational large battery storage facility Σ 48.6 MW
(status as of 7/2024)
AVE Milada
AVE
AVE
AVE Most
AVE
AVE Medard
Baterie Tušimice 4 MW
Baterie Kr.Poříčí 5 MW
PVE Libochovany
Baterie Vraňany 26,6 MW
PVE Pastviny
PVE Dlouhé stráně 650 MW
Baterie Vítkovice 10 MW
PVE Slezská Harta
PVE Štěchovice II 45 MW
PVE Slapy
PVE Orlík
PVE Vinice
Baterie Mydlovary 1 MW
PVE Černé jezero 1,5 MW
PVE Dlalešice 475 MW
Baterie Prakšice 1 MW
Identified sites for new PHES (according to MoE CR) up to Σ 1222 MW
AVE Potential AVE – 2n sites – up to Σ (1 000 - 15 600) MW
Transmission grid of the ČR - 2023
400 kV lines
400 kV lines under construction
220 kV lines
220 kV lines under construction
Power plant
Temporarily out of service
Substation
Substation under construction

Maximum Achievable Parameters Using Full Potential of Selected Lakes

Lake	Accumulation capacity	Maximum output	Number of power units	Number of modules
	[GWh]	*[GW]*	*[ks]*	*[ks]*
Medard	48,9	8,1	3 708	271 387
Most	33.4	5,6	3 087	197 127
Milada	11.5	1,9	3 075	157 766
Lake	**Pumped water volume**	**Average discharge height**	**Estimated costs**	**The specific investment cost**
	[mil. m³]	*[m]*	*[bn. €]*	*[€/kWh]*
Medard	39,1	470	28	574
Most	27	463	20	597
Milada	12,8	332	6	523

Grid Connection Analysis MPHES-2R

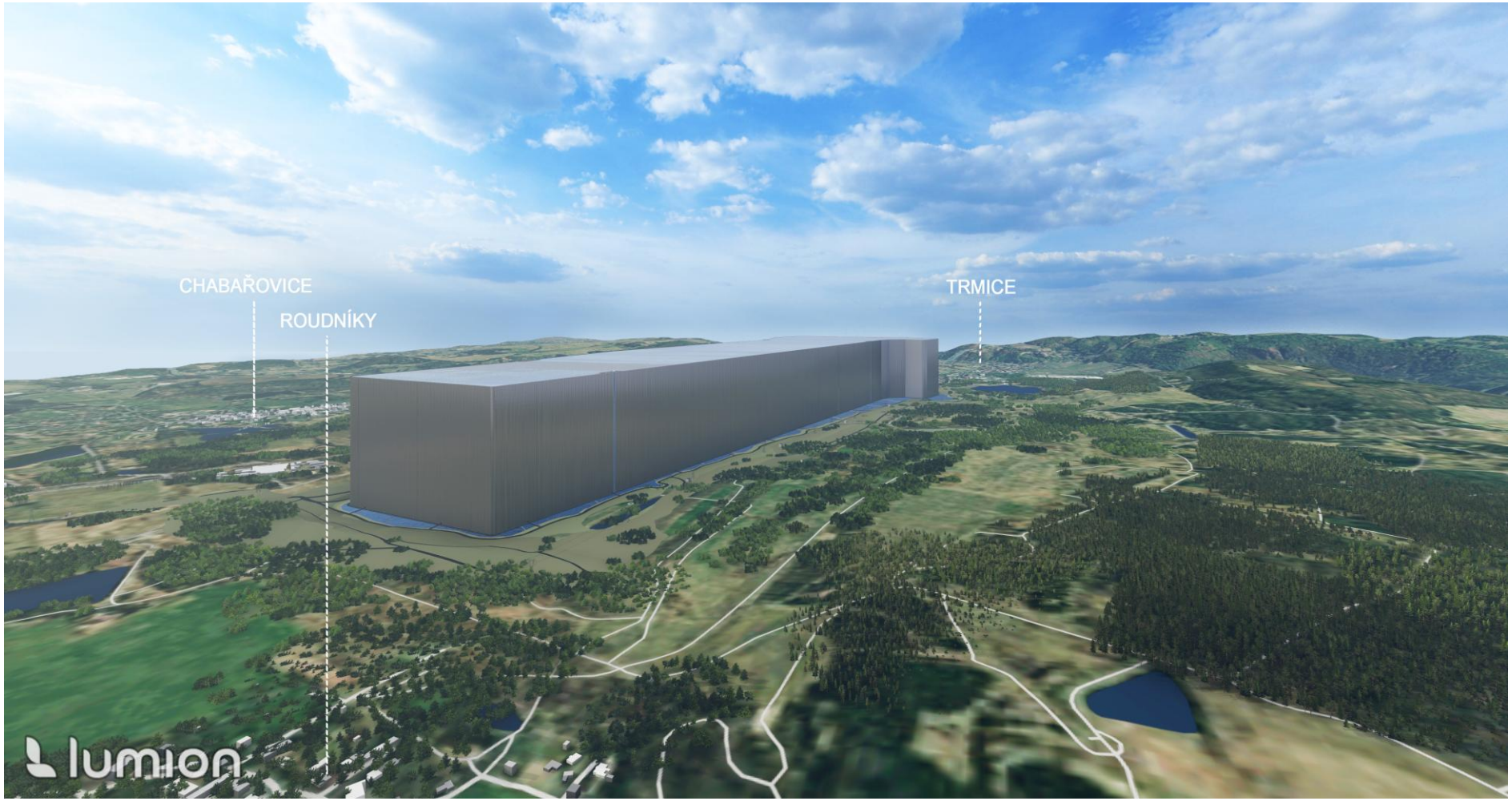
- Feasible power range: 1000–2000 MW
- Connection via double 400 kV lines
- Simulation of complete connection, including N-1 failure scenarios
- Some grid reinforcements required
- Site-specific capacities:
  - Milada – 1000 MW
    (minor modifications for N-1)
  - Most – 1000 a 1500 MW
    (major modifications needed)
  - Medard – 1000 až 2000 MW
    (unsuitable due to extensive grid upgrade needs)



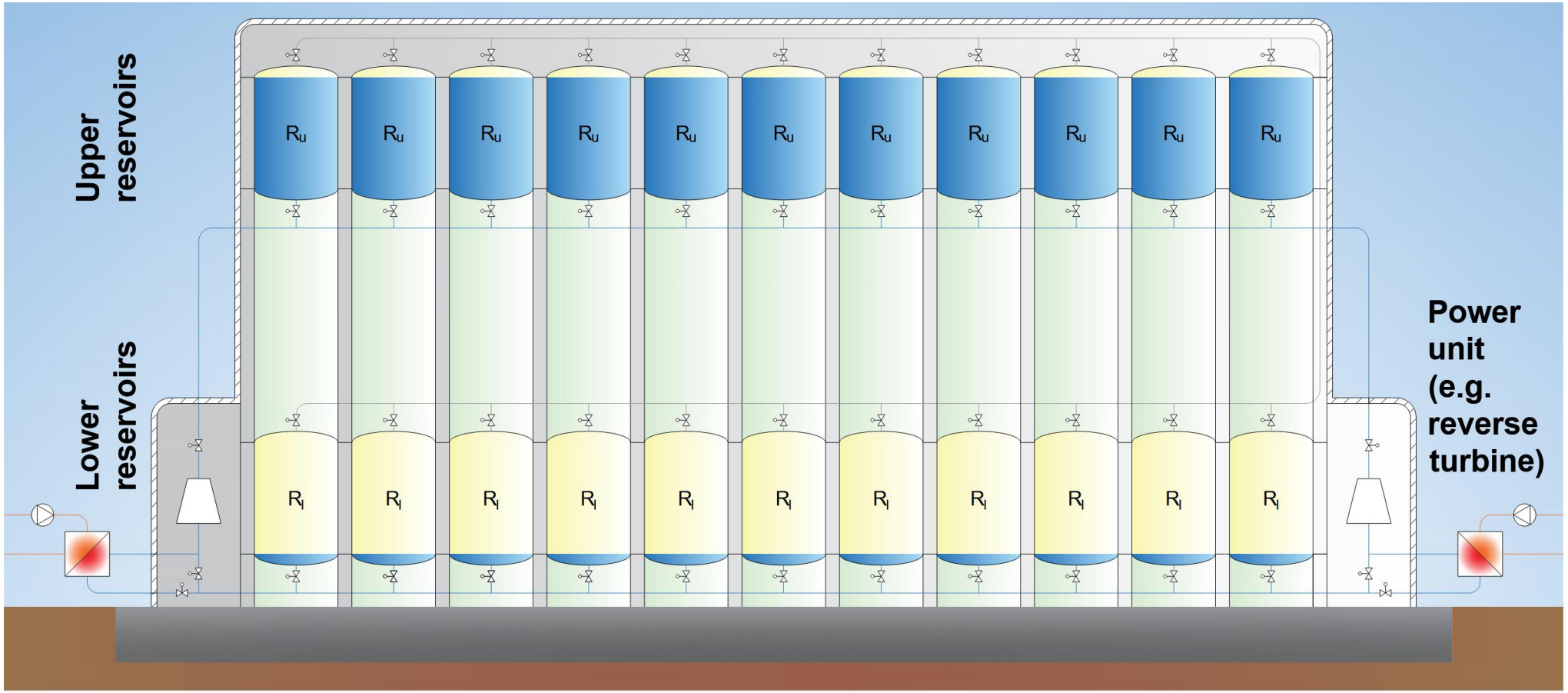
MPHES-2R Milada

Dimensions 3120 x 690 x 332 m

Visualization of maximum facility size for this location



MPHES-FR


Upper reservoirs
Lower reservoirs
Power unit (e.g. reverse turbine)
Ru
Rl
power unit
cooling system/hot water pump
automatically controlled control valve
water pipes
air/gas pipes
hot water pipes
cooling system/hot water exchanger
R reservoir
l lower
u upper
air/inert gas in the intermediate tube
air/inert gas in the envelope of a storage power plant
pumped water in reservoirs
displaced air air/inert gas inreservoirs
thermal insulation

Visualization – MPHES-FR

- **Footprint**: 150 x 150 m
- **Height**: 450 m
- **Storage capacity**: 0,45 GWh
- **Electric output**: 37,5 MWel (peak 75 MWel)
- **Thermal output**: 1,3 MWt (2255 apartments)
- **Total efficiency**: 82 %
- **Investment cost**: 10 bn. CZK (22 800 Kč/kWh), 0,4 bn. € (909 €/kWh)

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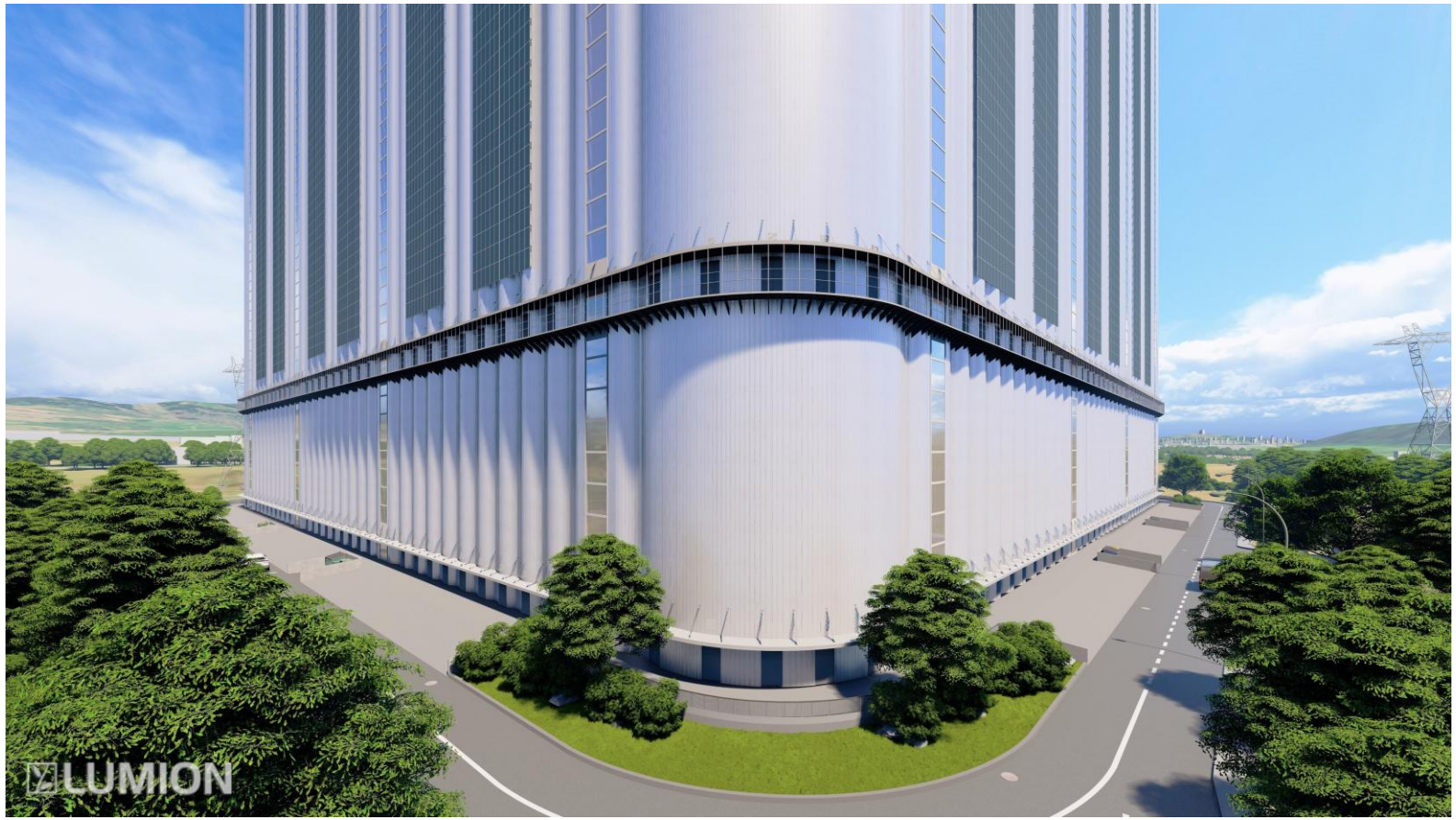

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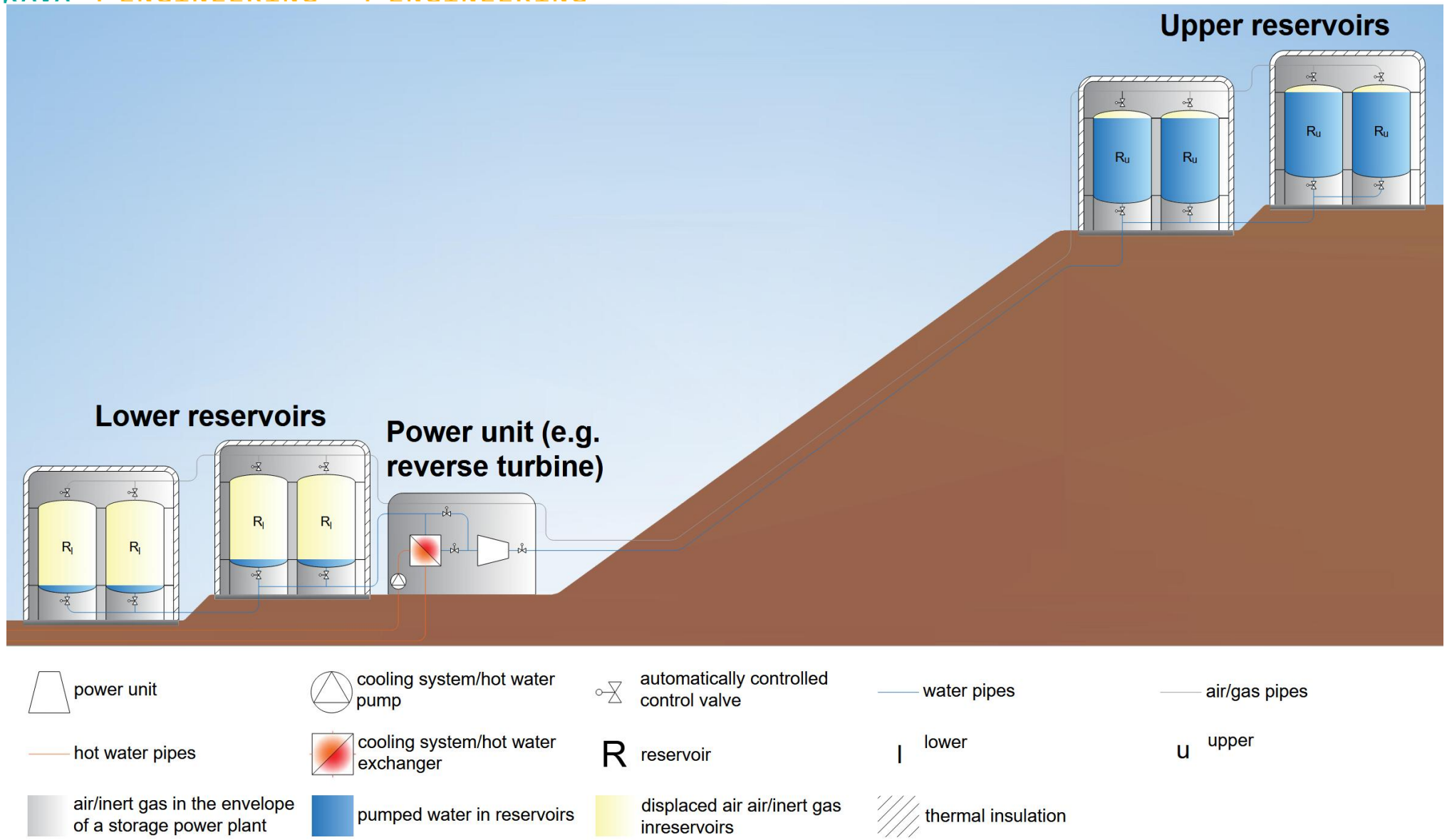
MPHES-SFR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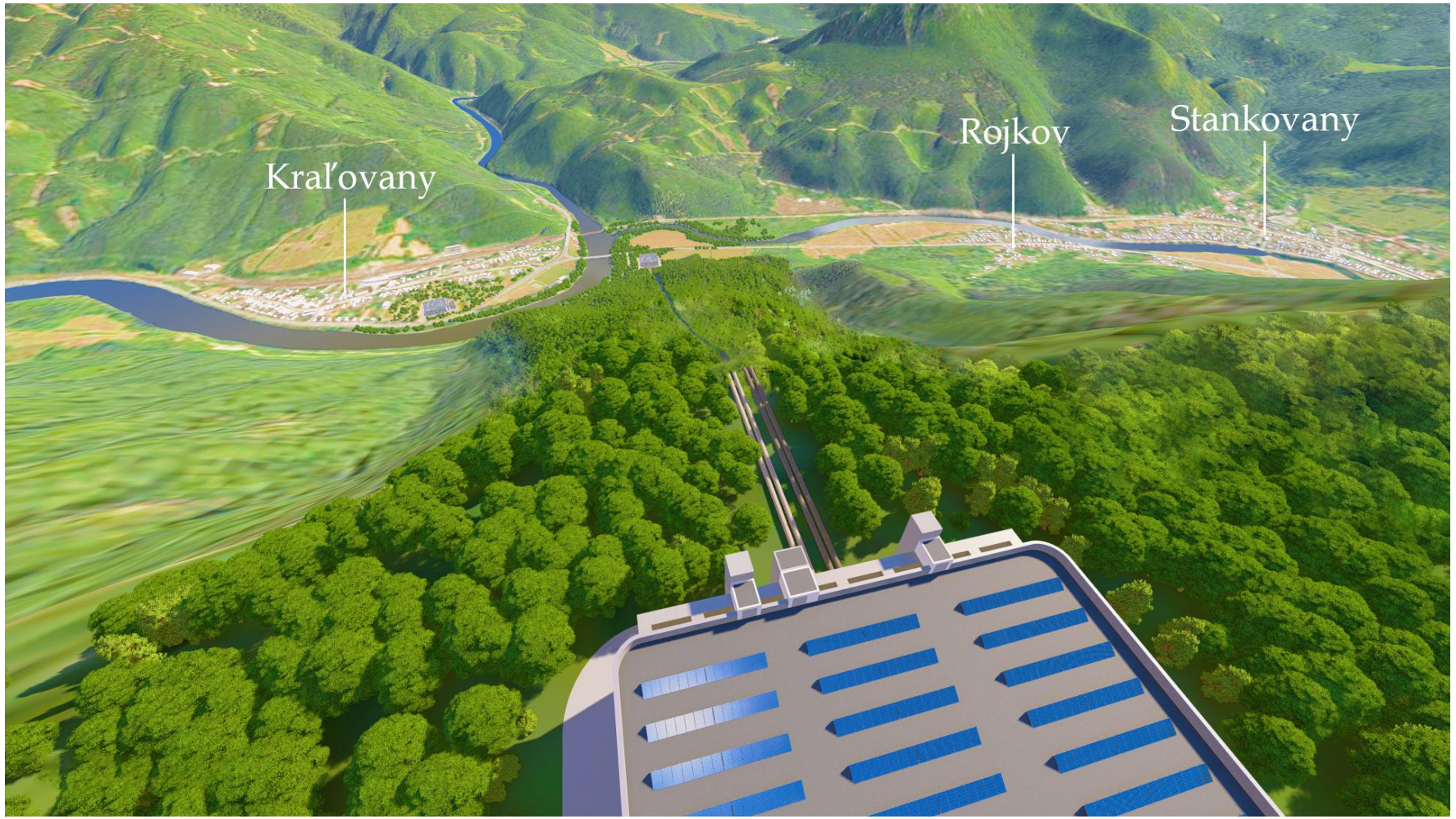
Visualization – MPHES-SFR

- **Footprint**: 60 × 60 m
- **Tank height**: 15 m
- **Head**: 700 m
- **Storage capacity**: 76 MWh
- **Electric output**: 6.3 MWel (peak 12.6 MWel)
- **Thermal output**: 0.34 MWt (for 590 apartments)
- **Total efficiency**: 88%
- **Investment cost**: CZK 480 million (CZK 6,350/kWh), €19 million (€252/kWh)



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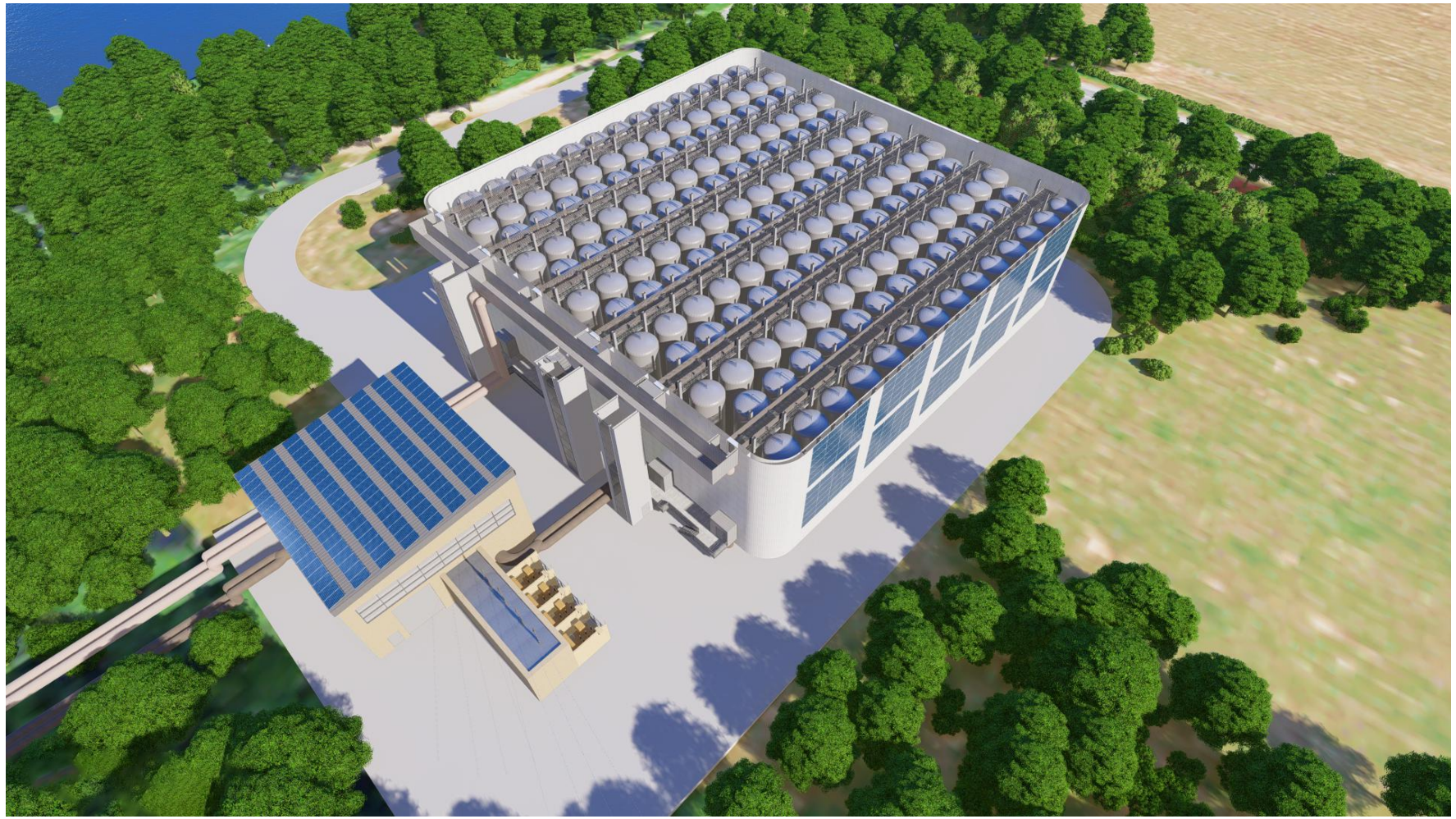

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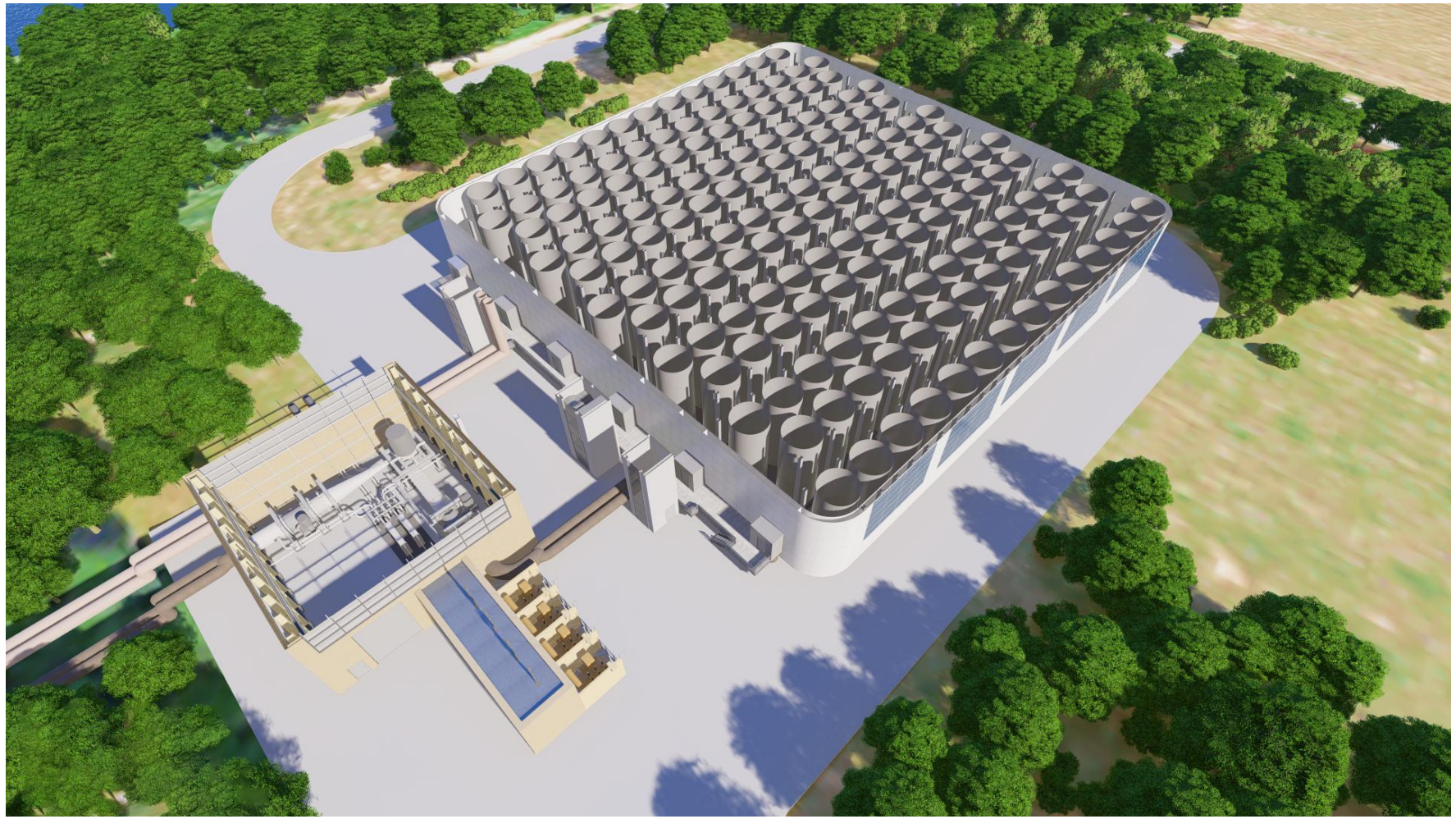

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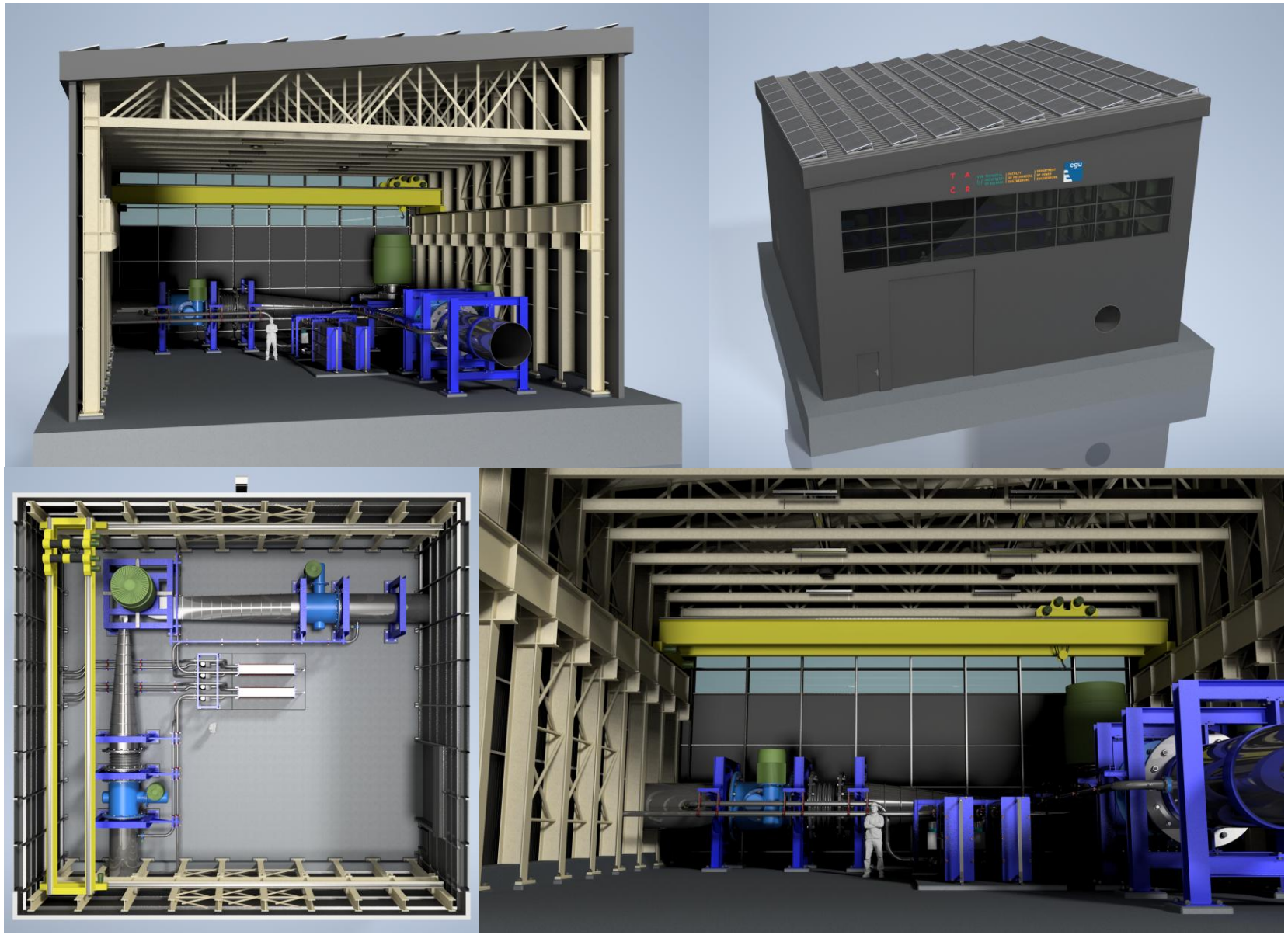

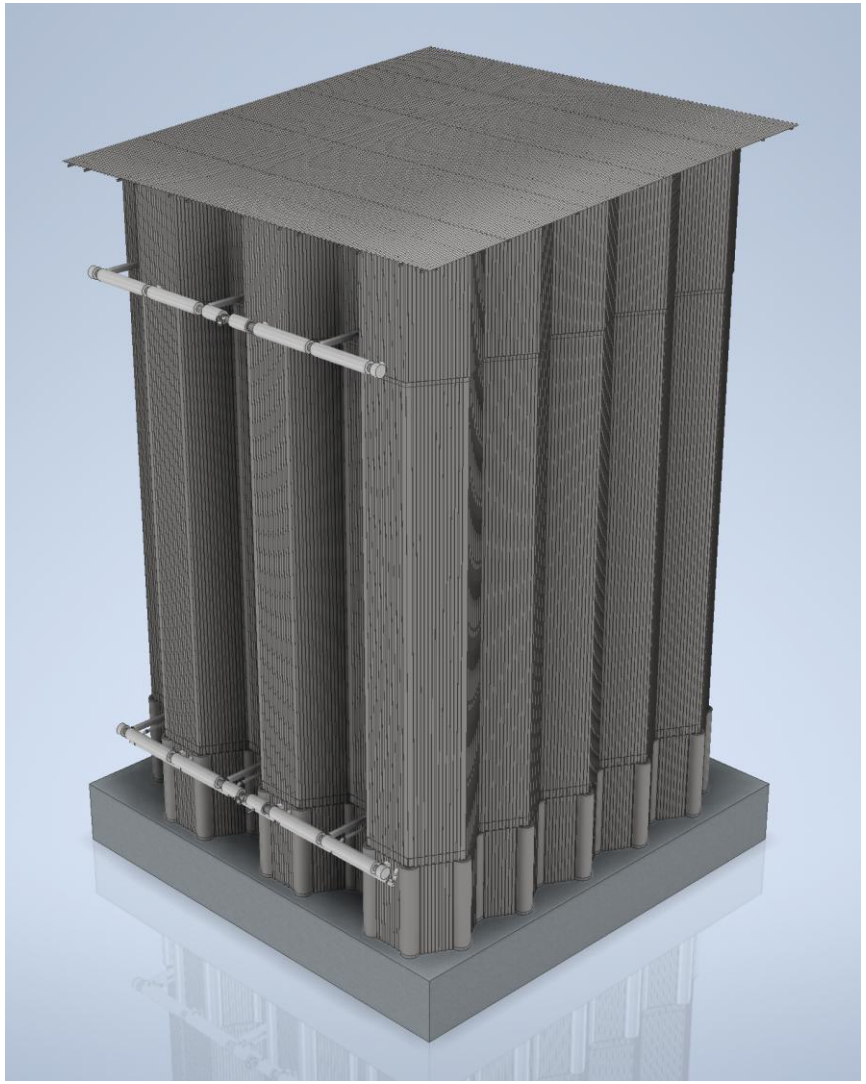

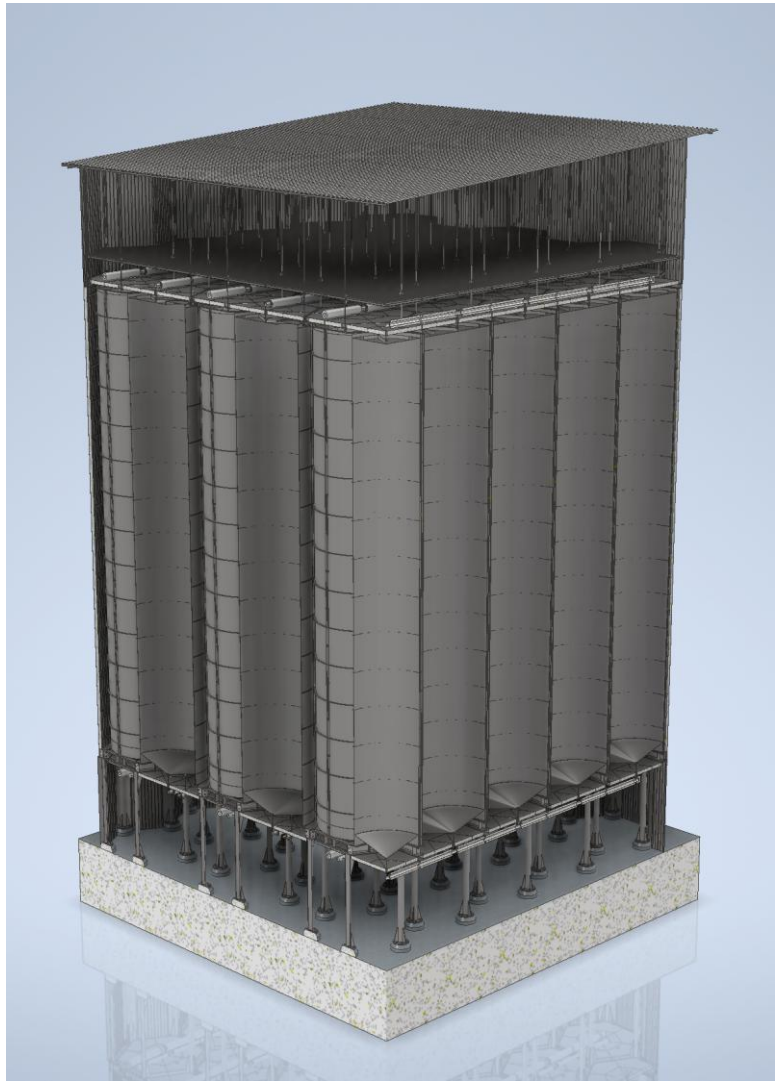

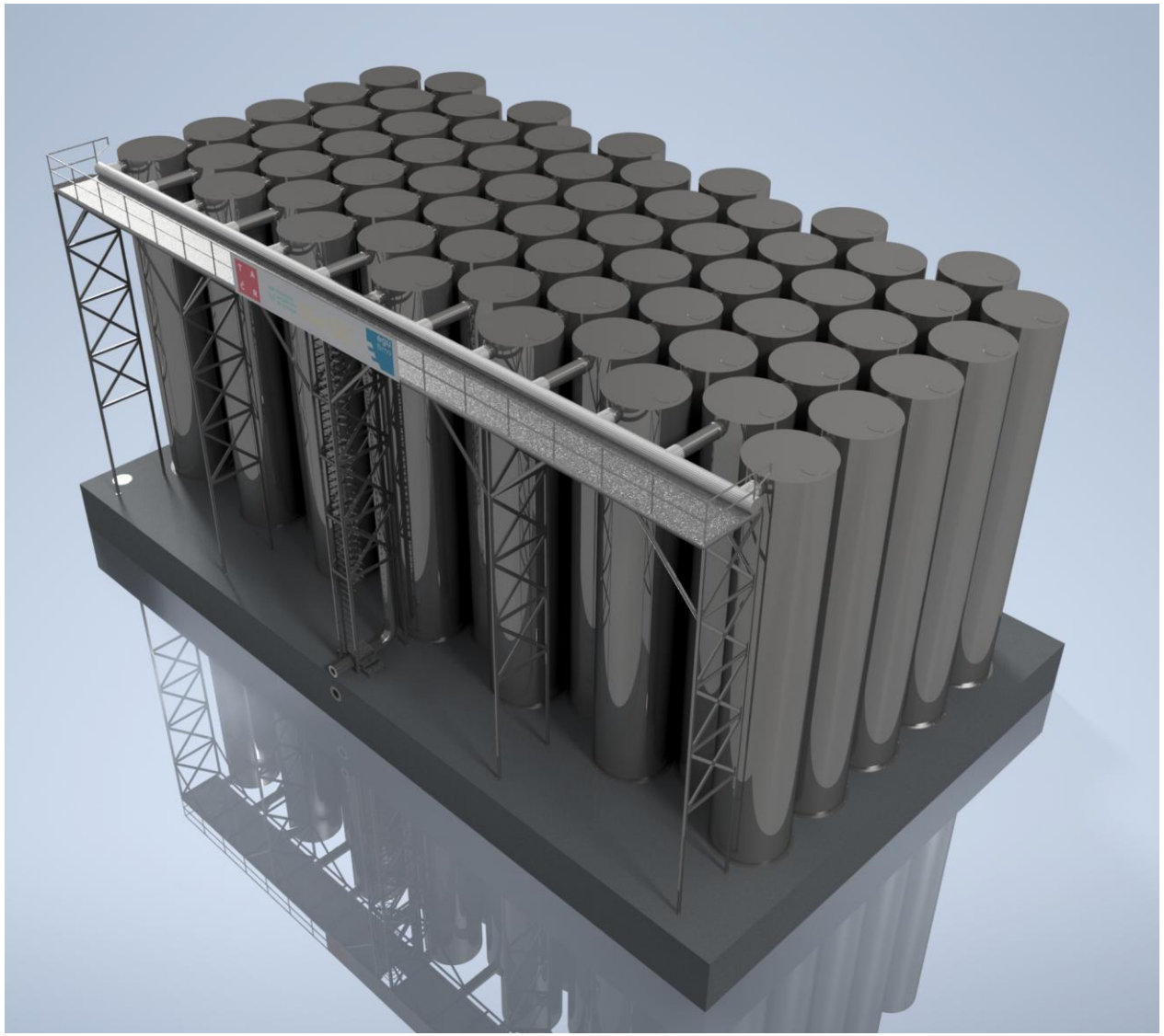

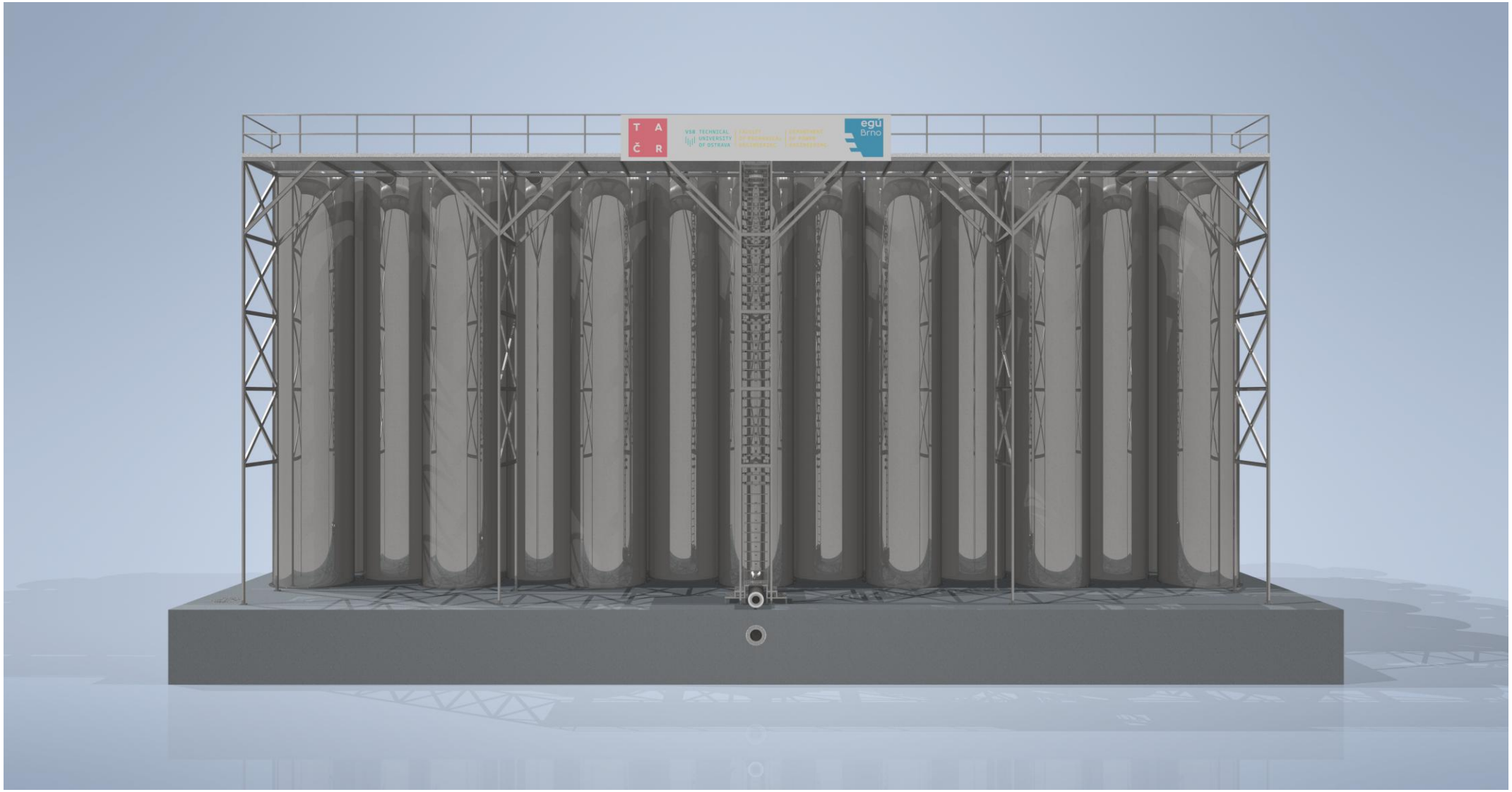

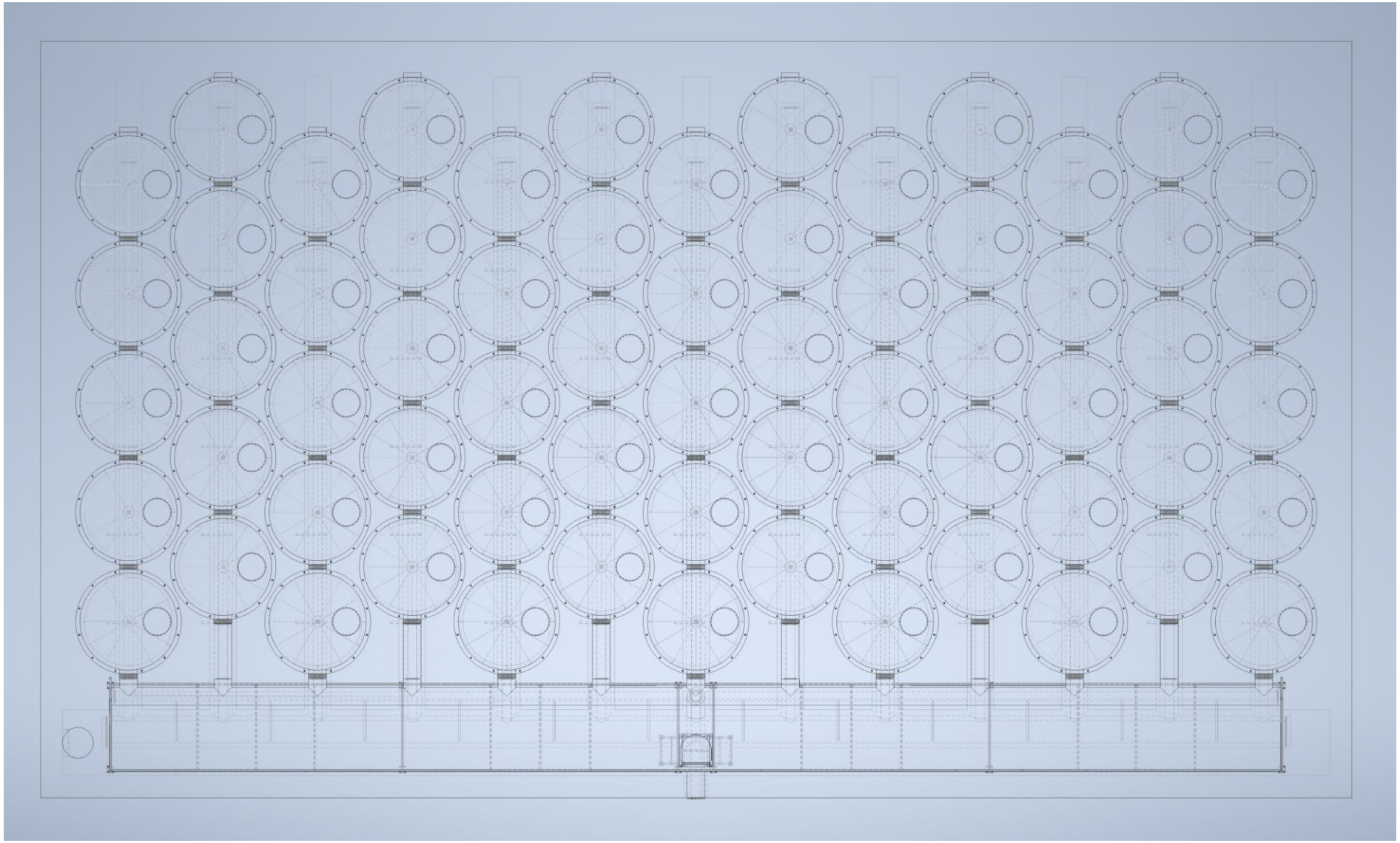

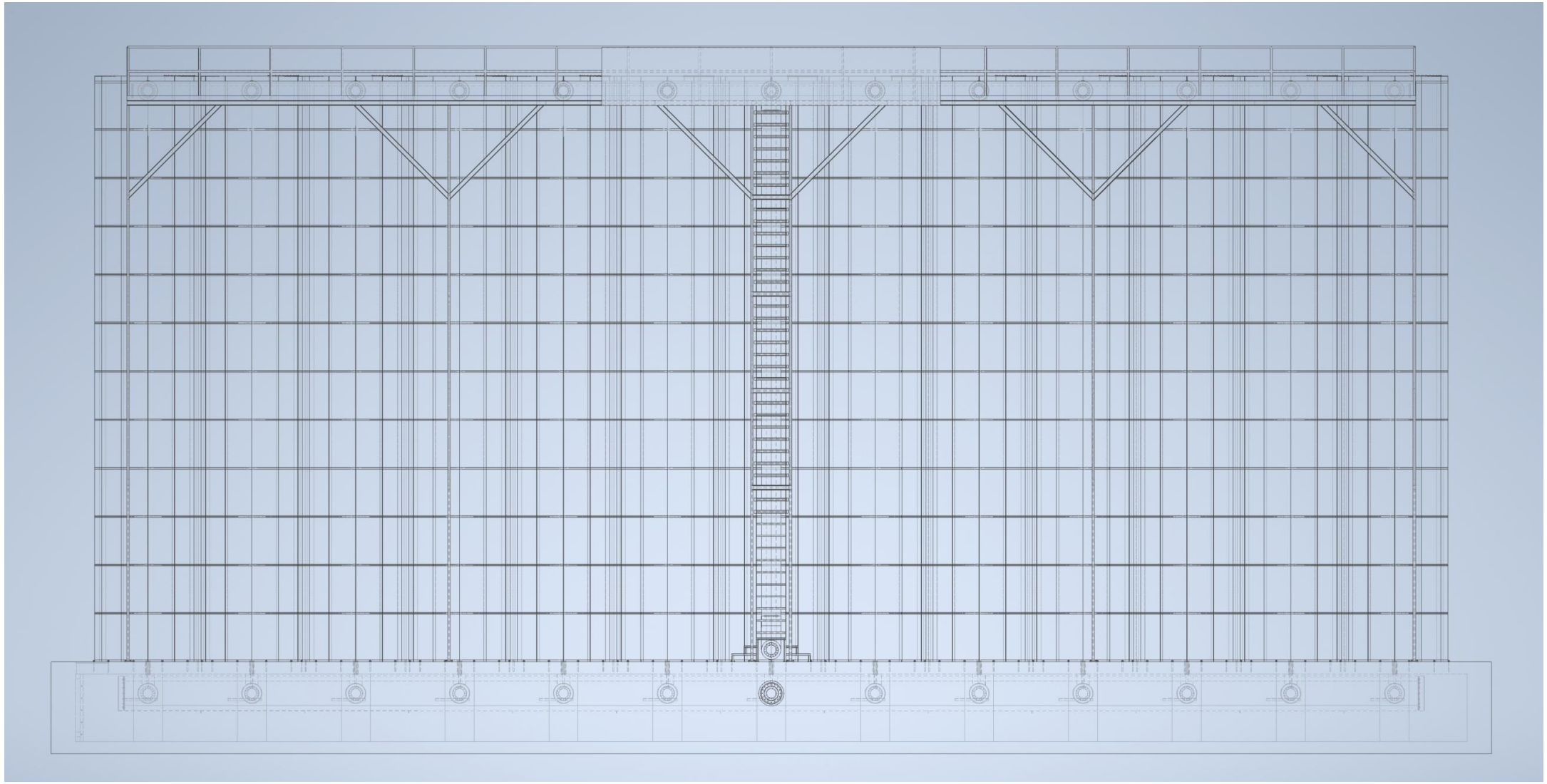

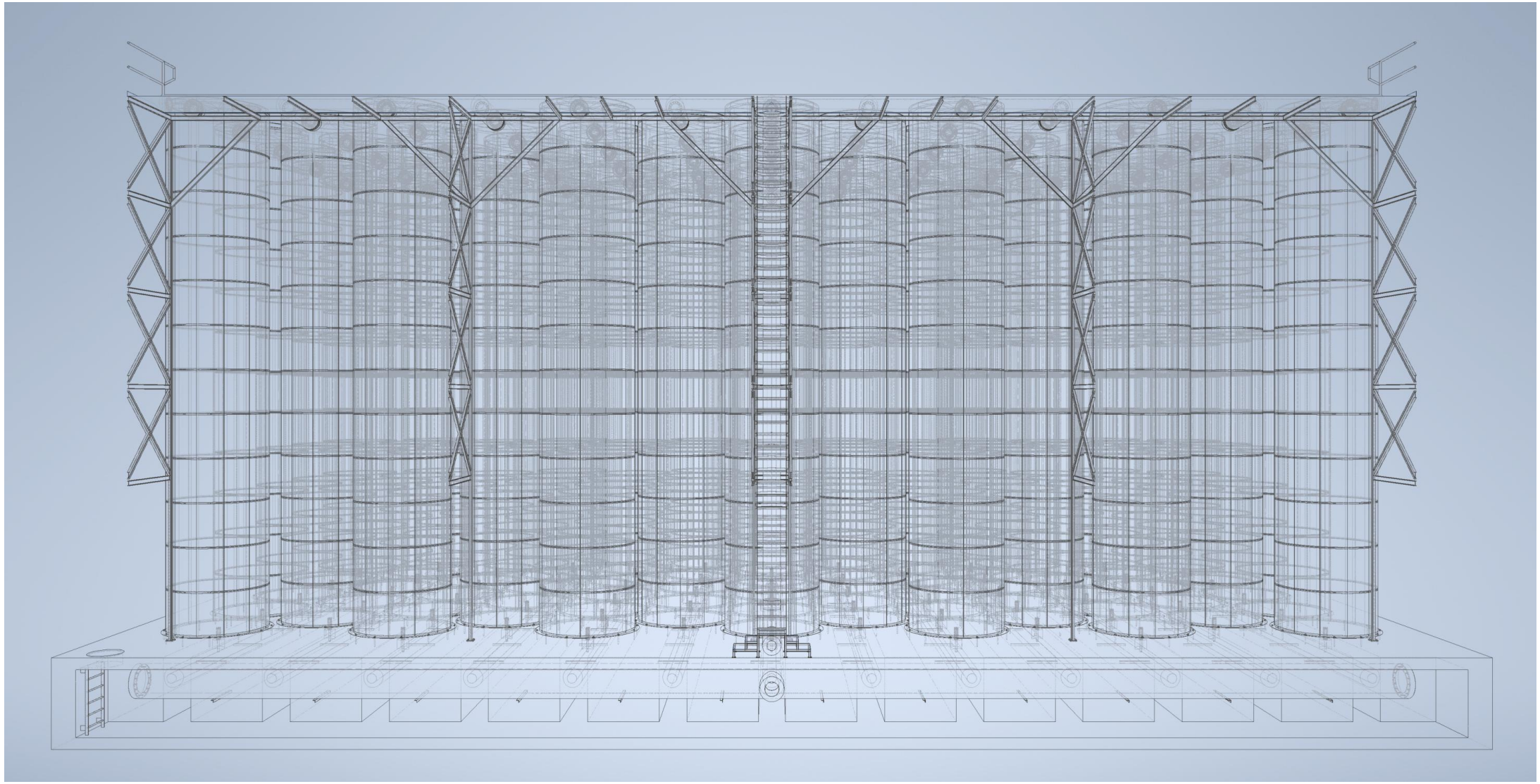

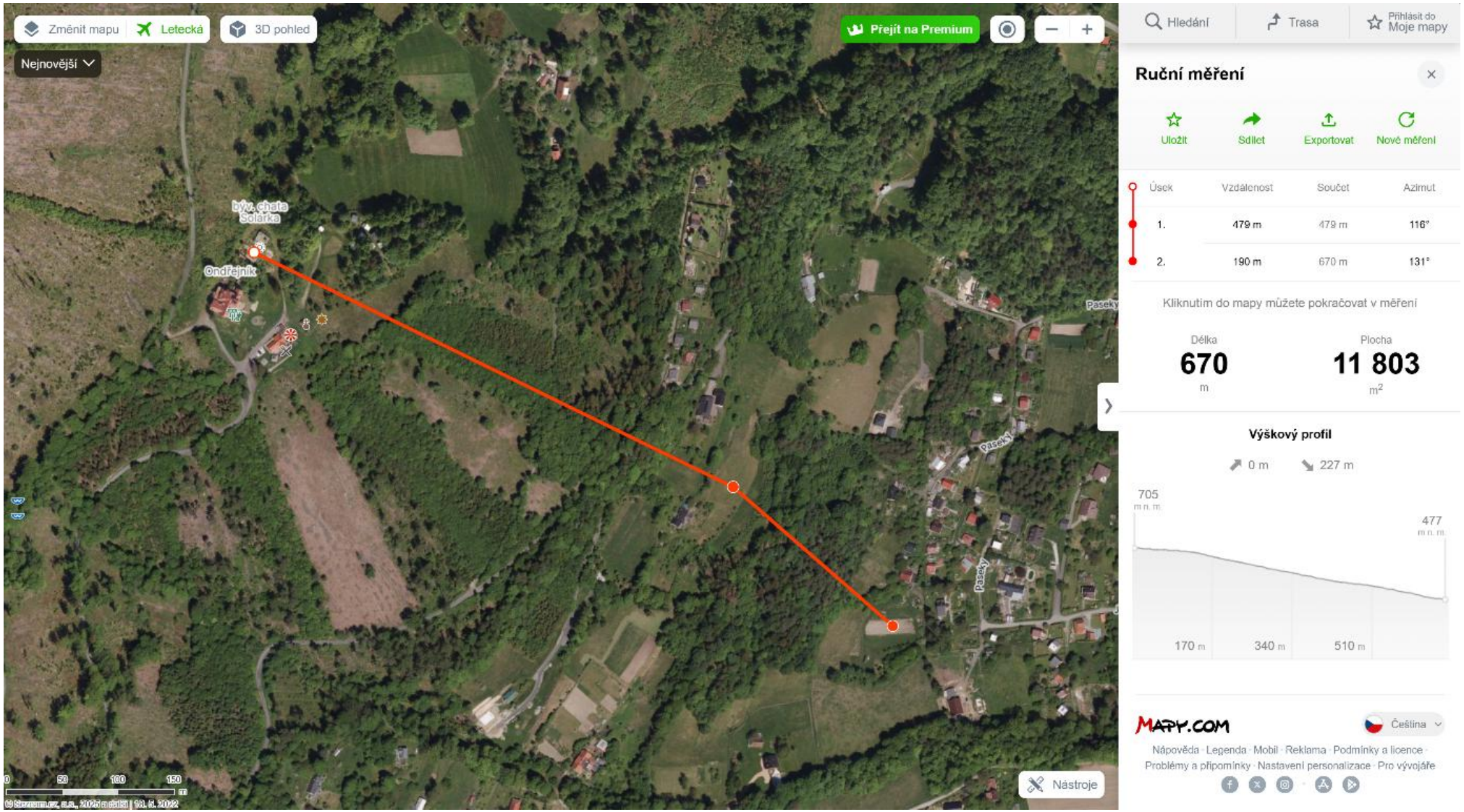
Změnit mapu
Letecká
3D pohled
Přejít na Premium
Nejnovější
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Hledání
Trasa
Přihlásit do Moje mapy
Ruční měření
Uložit
Sdílet
Exportovat
Nové měření
Úsek
Vzdálenost
Součet
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479 m
479 m
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340 m
510 m
Nástroje
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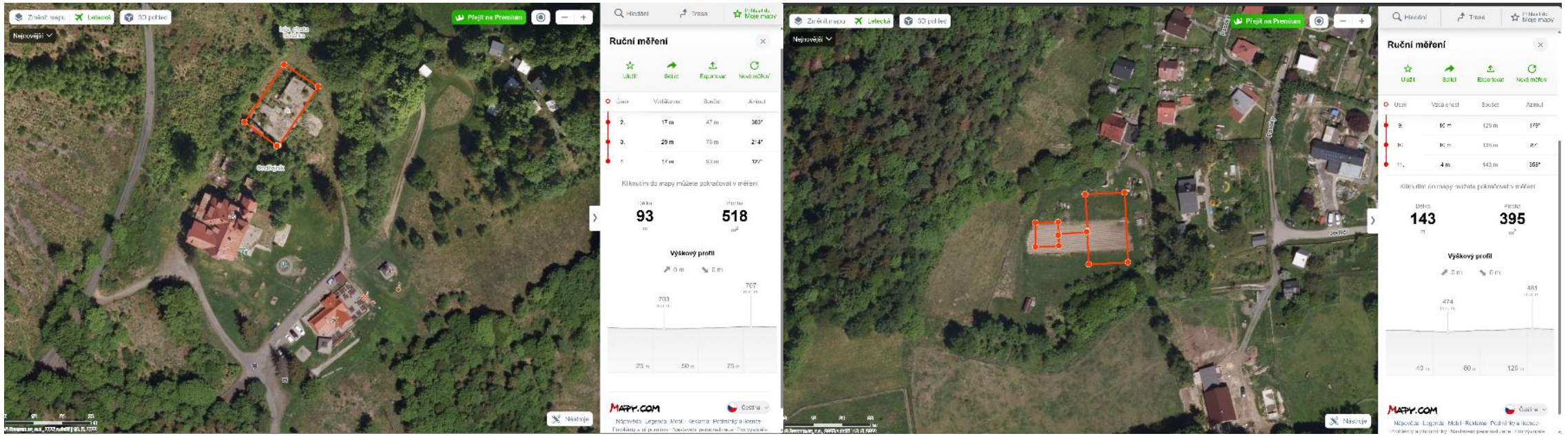
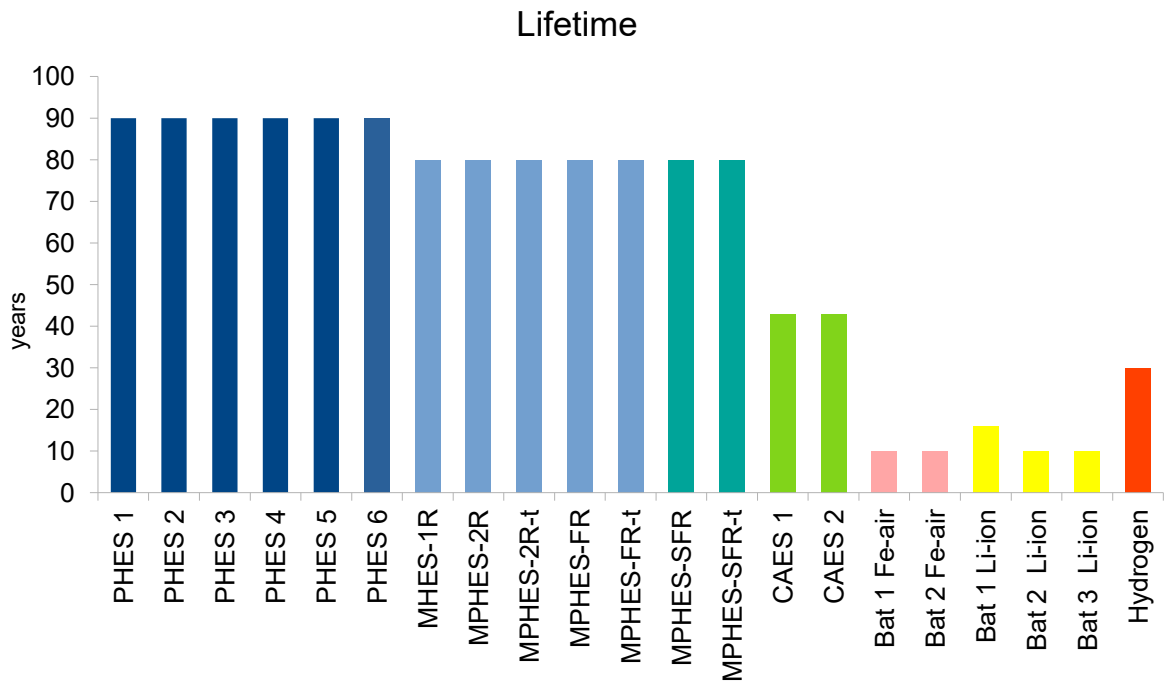
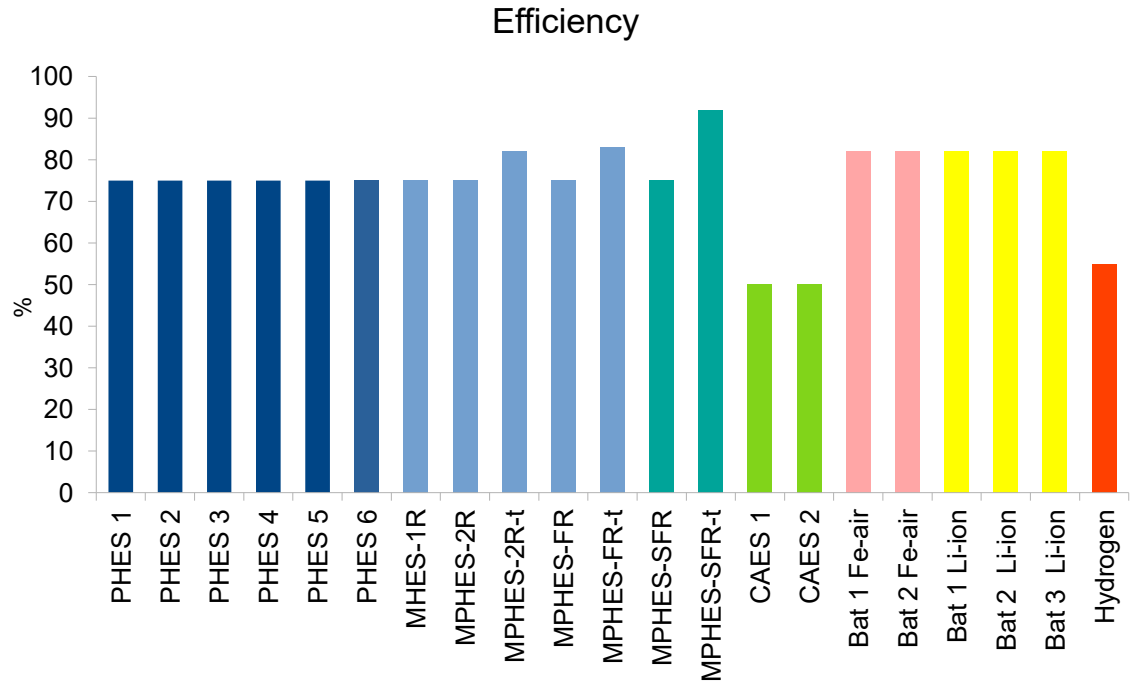

Ruční měření
93
518
Výškový profil
Ruční měření
143
395
Výškový profil

Comparison with Competing Technologies





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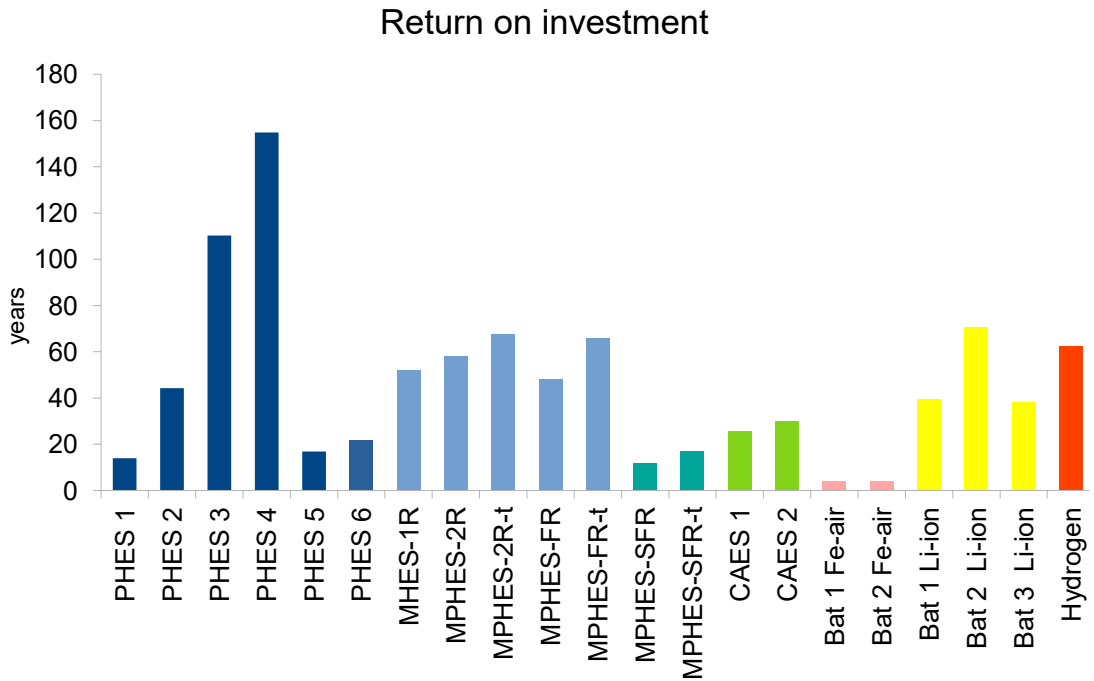
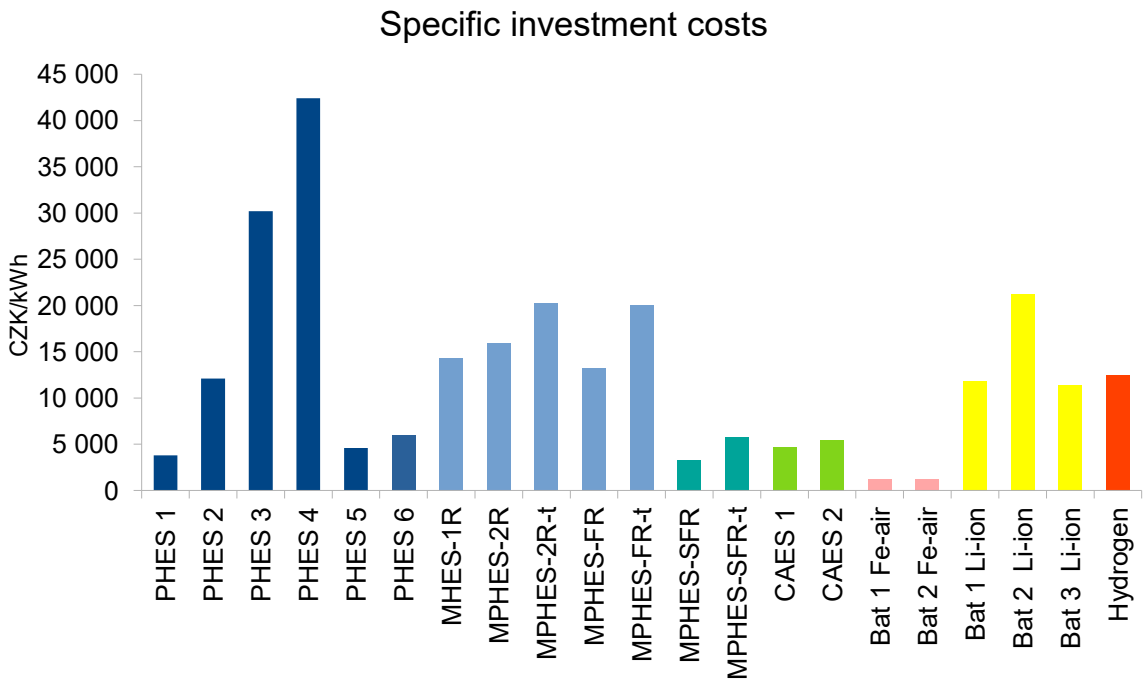
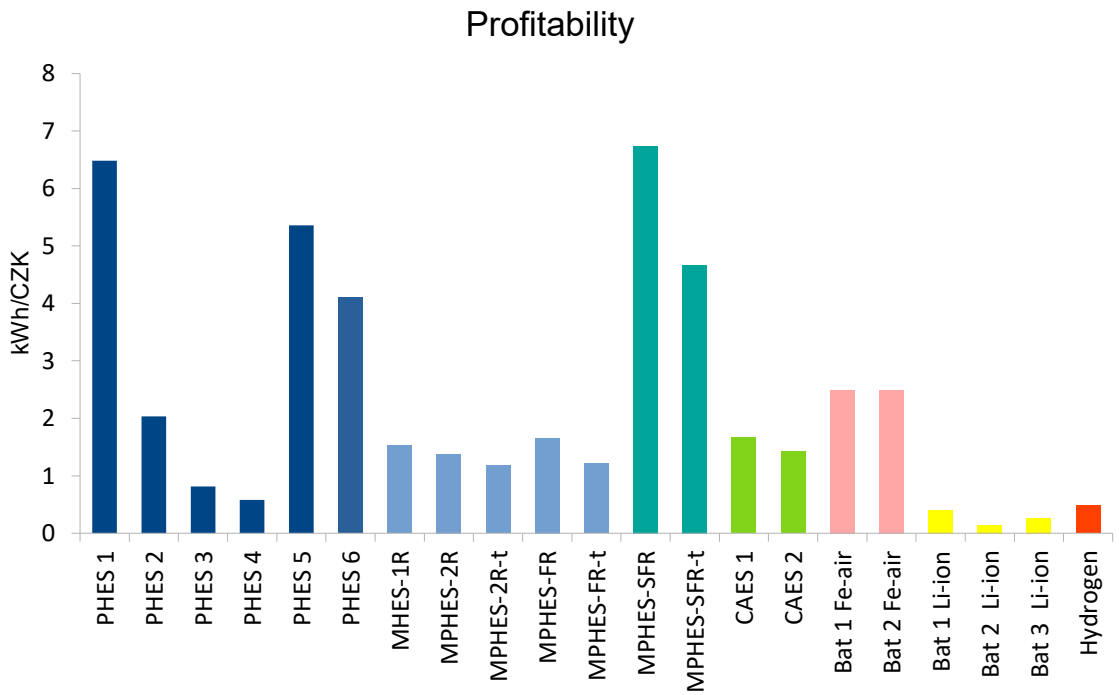
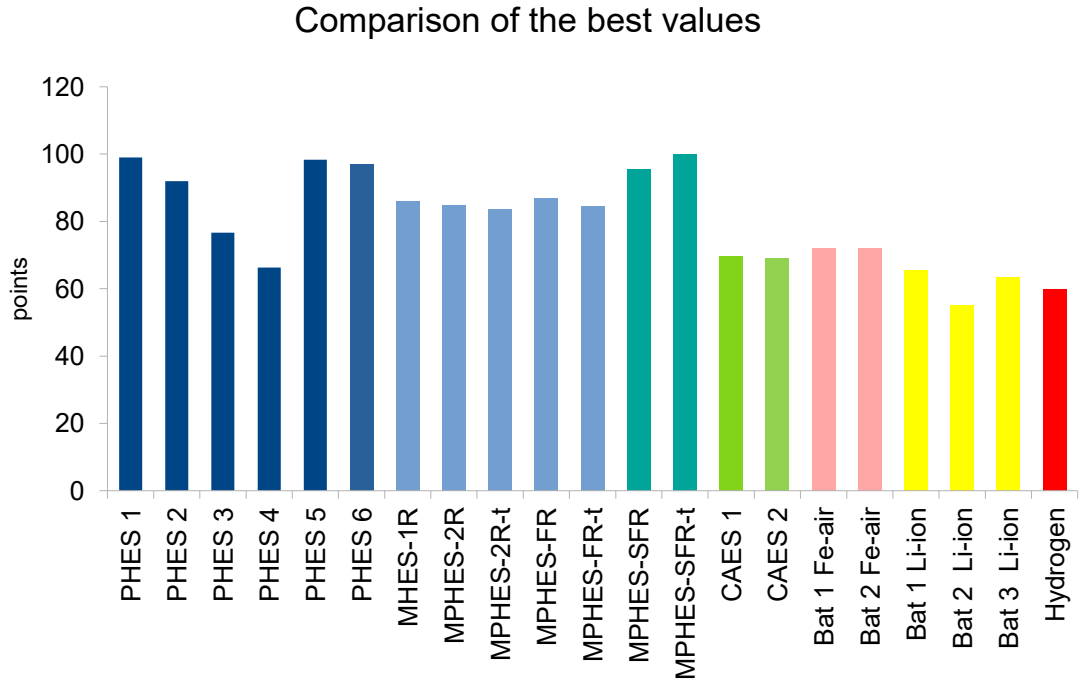




Payback and Profitability Calculated at Electricity Price of **CZK 1/kWh (€0.04)**

Comparison with Competing Technologies





Payback and Profitability Calculated at Electricity Price of **CZK 1/kWh (€0.04)**

Acknowledgments

- This study was written in connection with the project *New Type of Pumped-Storage Hydroelectric Power Plant* (Reg. No. TK03030037), financed by Technology Agency of the Czech Republic and *REFRESH – Research Excellence For Region Sustainability and High-tech Industries* (Reg. No. CZ.10.03.01/00/22_003/0000048), financed by EU structural funds.

- This presentation was created in connection of the project: SP2025/100 - Specifický výzkum v oblasti zvyšování efektivity vybraných energetických procesů

Thank You for Your Attention

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